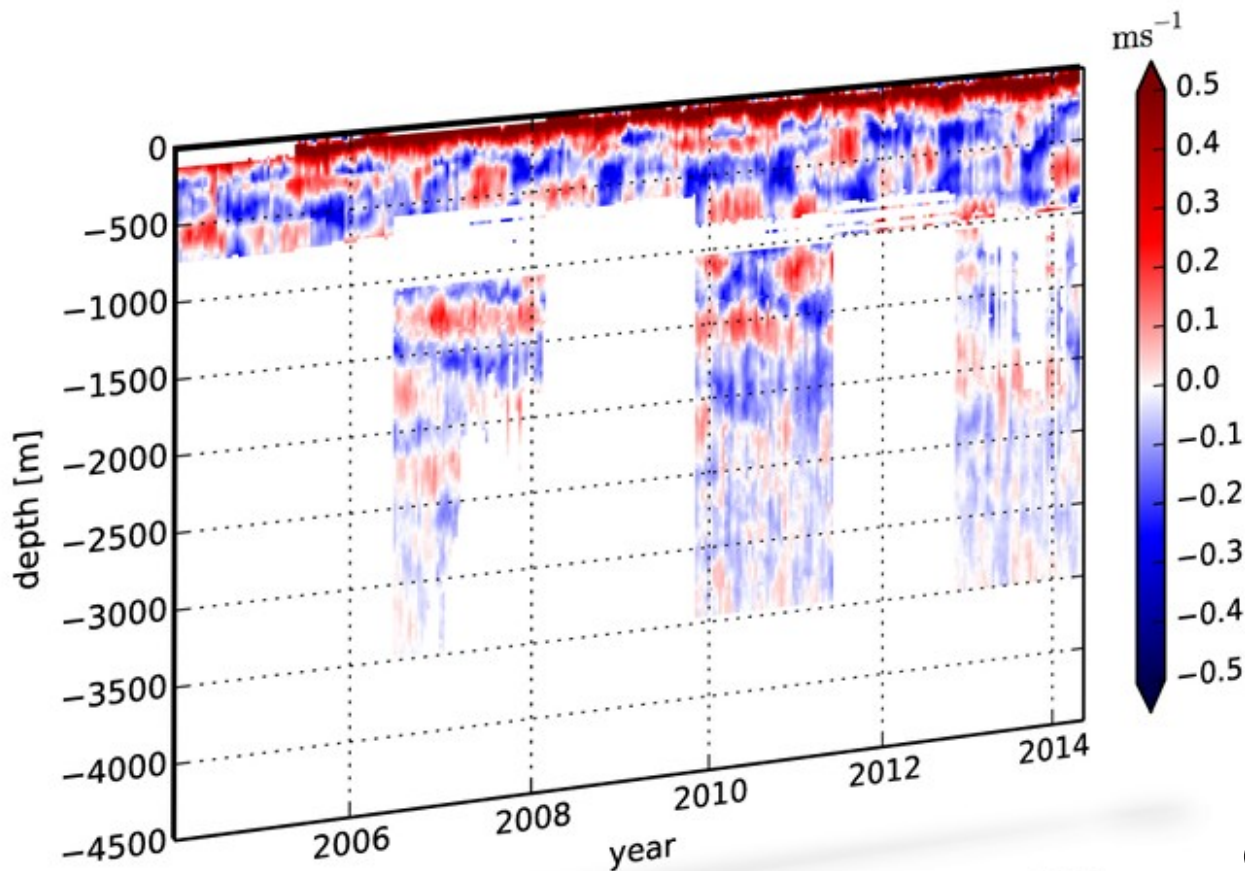


Maintenance of the seasonal cycle and the interannual variability by intra-seasonal chaotic variability in the equatorial Atlantic

M. Claus, R. J. Greatbatch, P. Brandt, F. P. Tuchen, C. Roth, J.-D. Matthießen

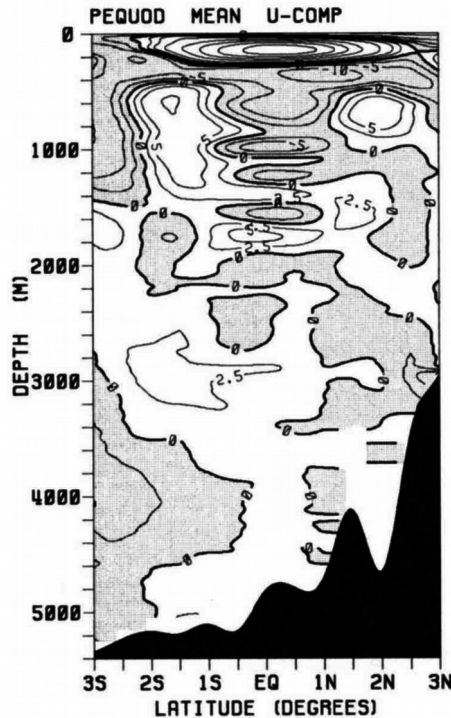


Hamburg, 03.05.2017

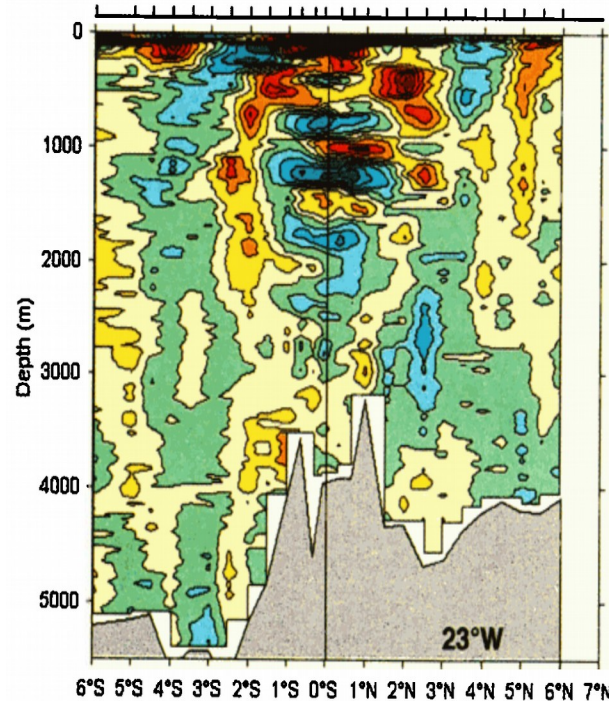
mclaus@geomar.de

Equatorial Deep Jets

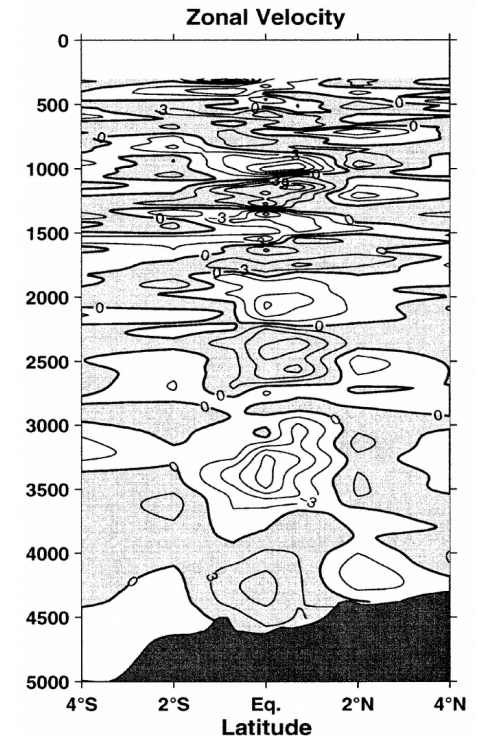
Pacific



Atlantic



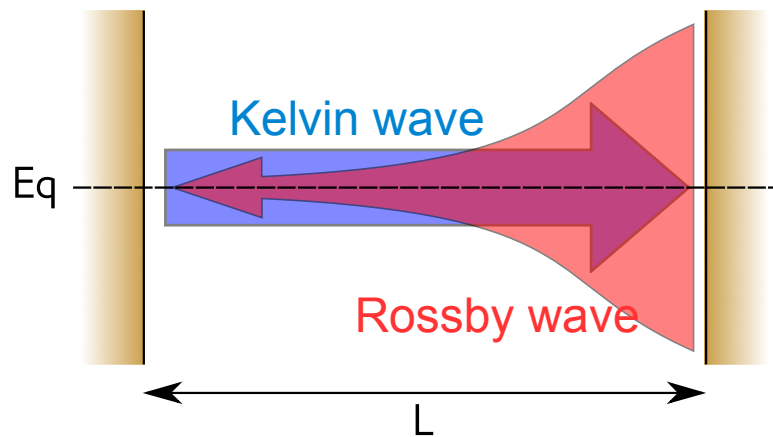
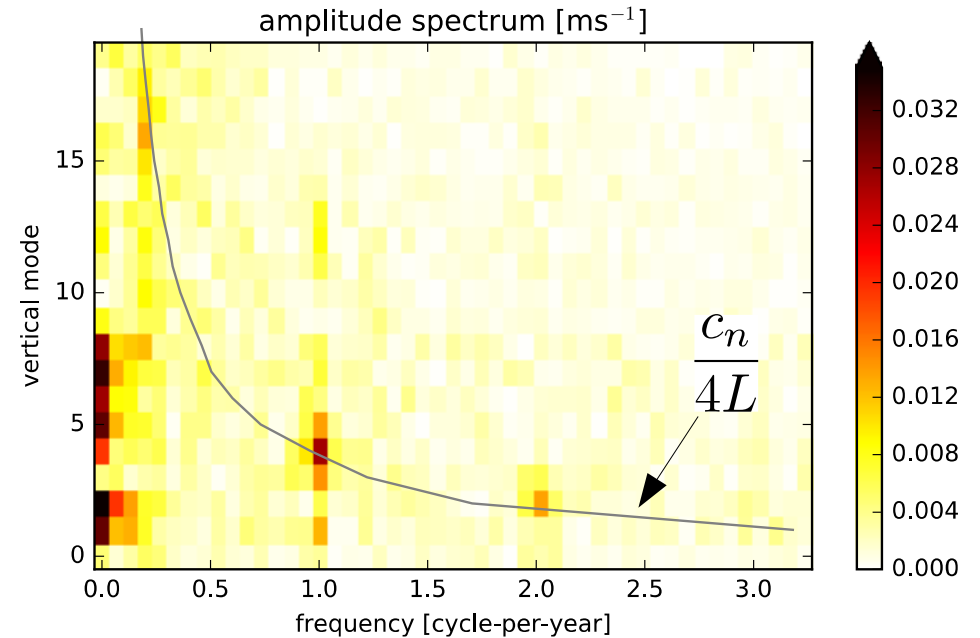
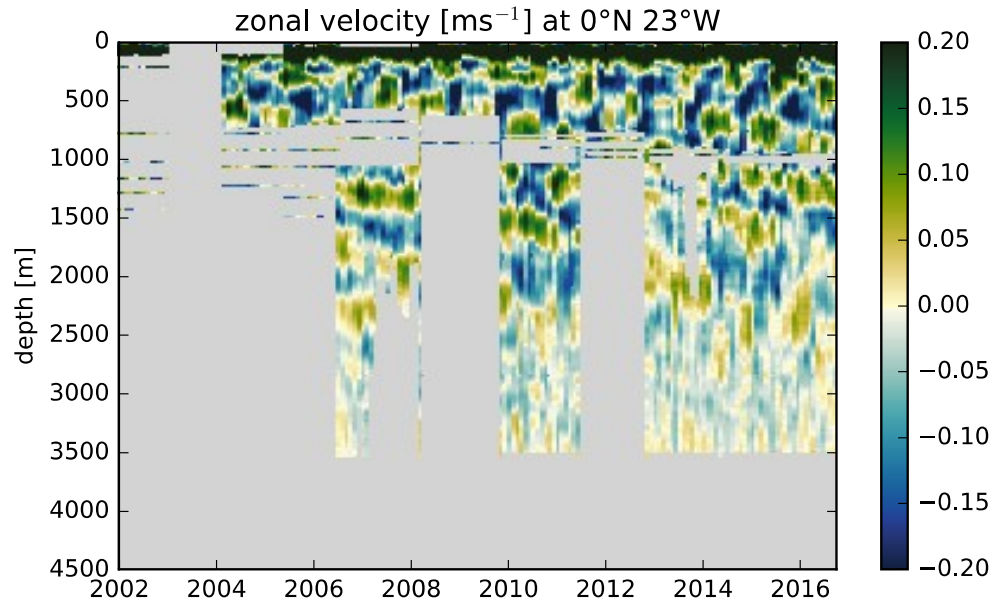
Indian Ocean



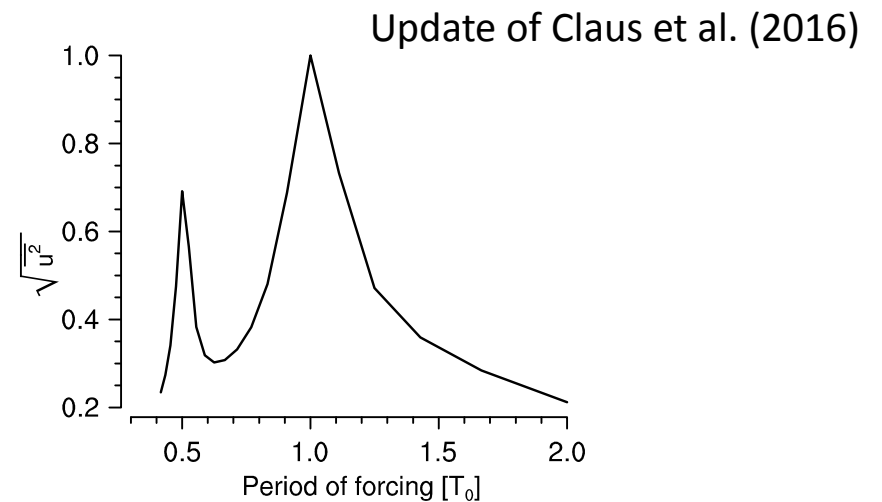
Vertical Mode	8 < 22 < 39	12 < 17 < 21	8 < 19 < 41
Width	1.00°	1.08°	1.09°
λ_x	144°	71°	71°
Period [yr]	10 < 12 < 15	4.6 < 4.8 < 5.0	4.4 < 4.9 < 5.6

Firing et al. (1987); Gouriou et al. (2001); Dengler & Quadfasel (2002);
Youngs & Johnson (2015)

Zonal velocity at 0°N, 23°W

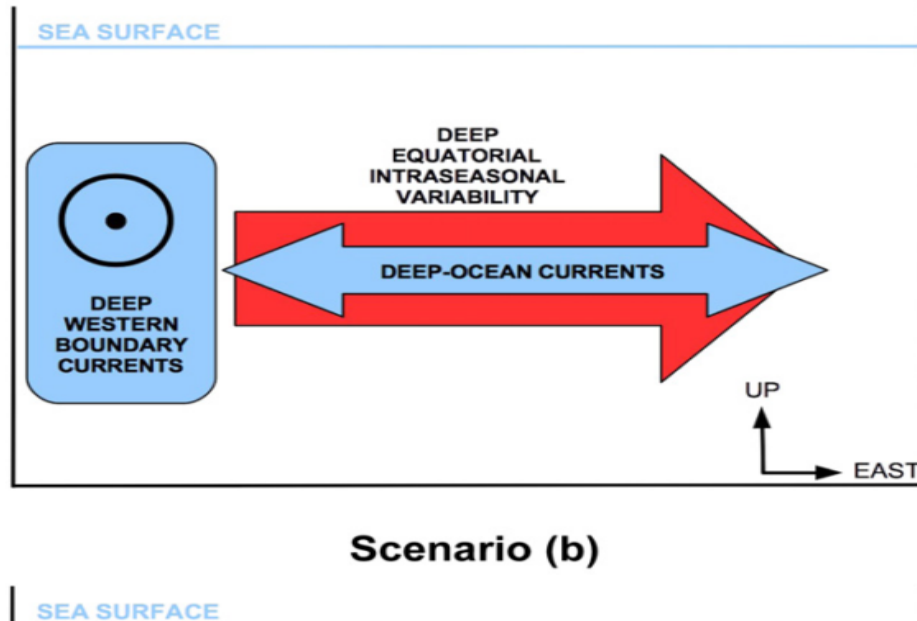


Cane & Moore (1981)



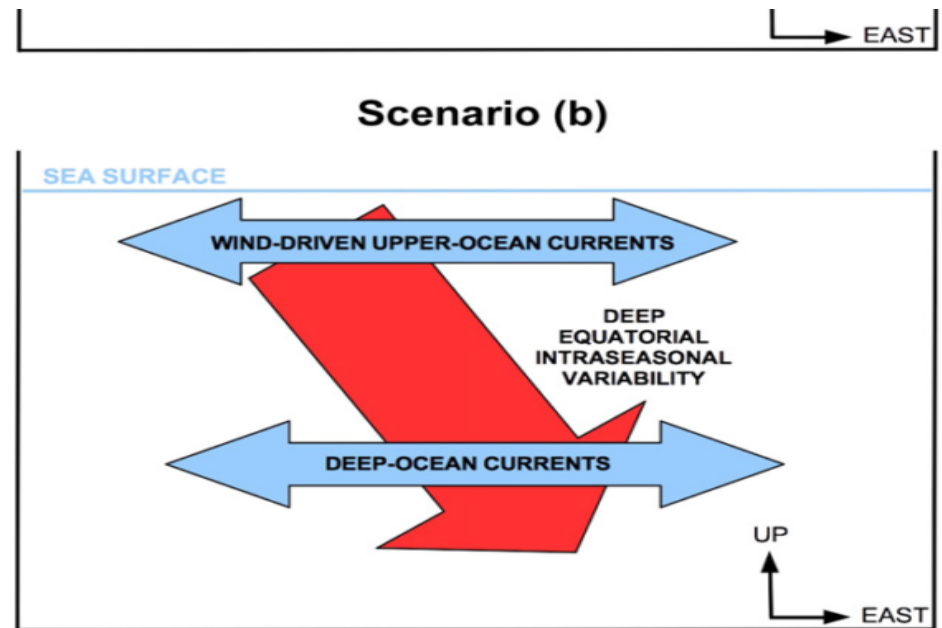
Proposed driving mechanisms of the EDJs

Rectification of intra-seasonal variability generated by fluctuations of the DWBC



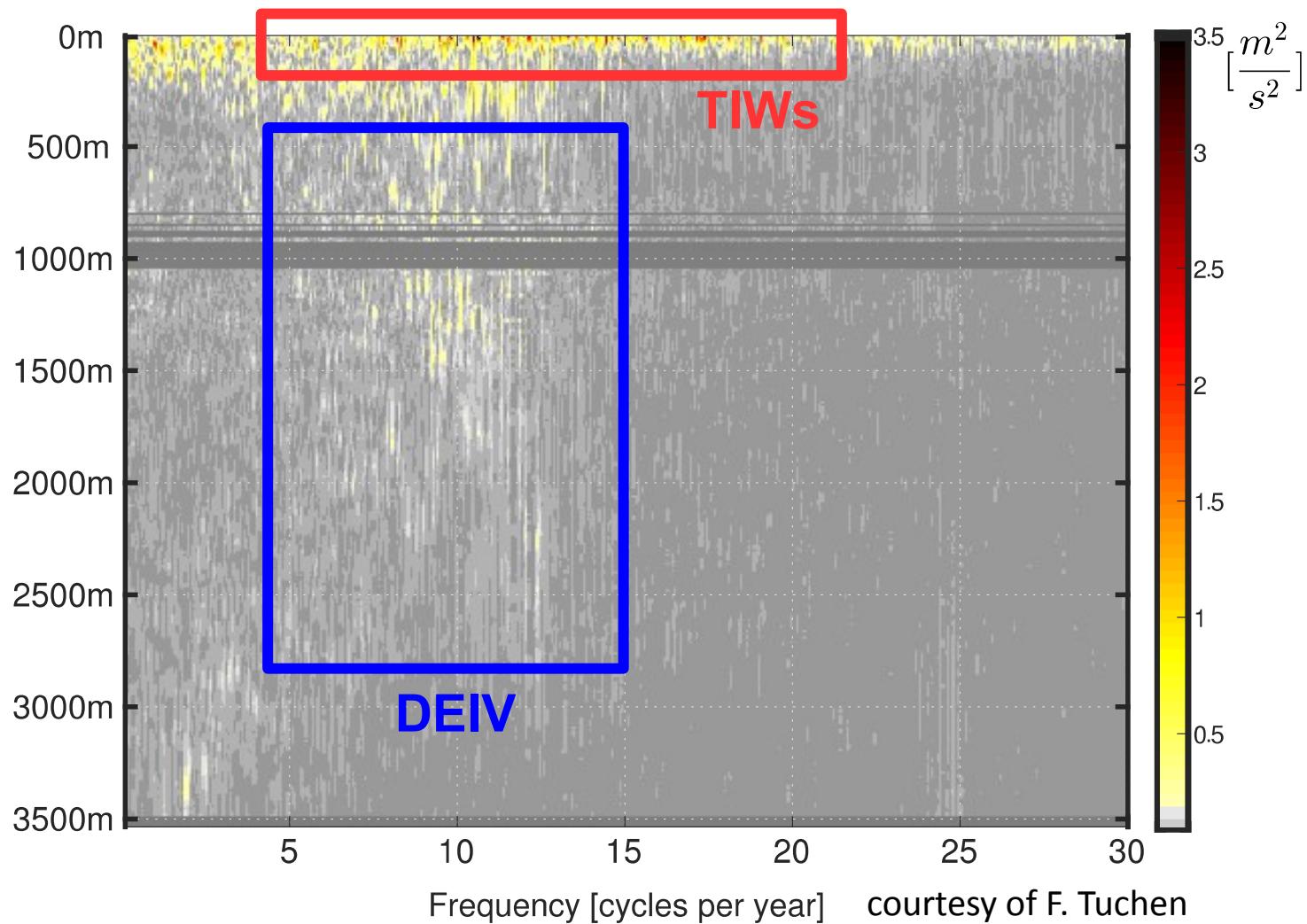
D'Orgeville et al. (2007); Hua et al. (2008)

Non-linear interaction of intra-seasonal variability generated by the instability of the surface circulation

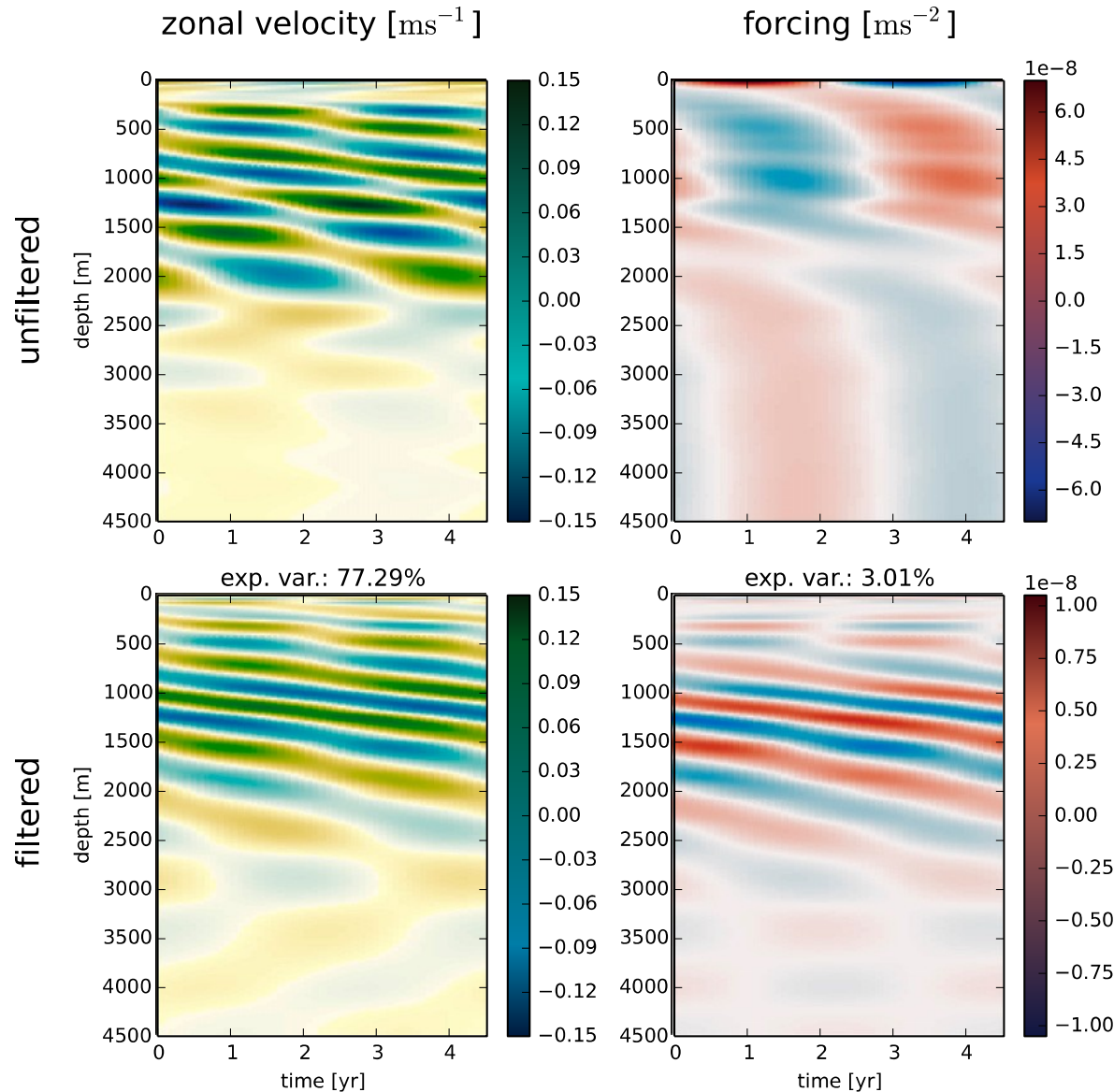


Ascani et al. (2015)

Energy spectrum of meridional velocity at 0°N, 23°W



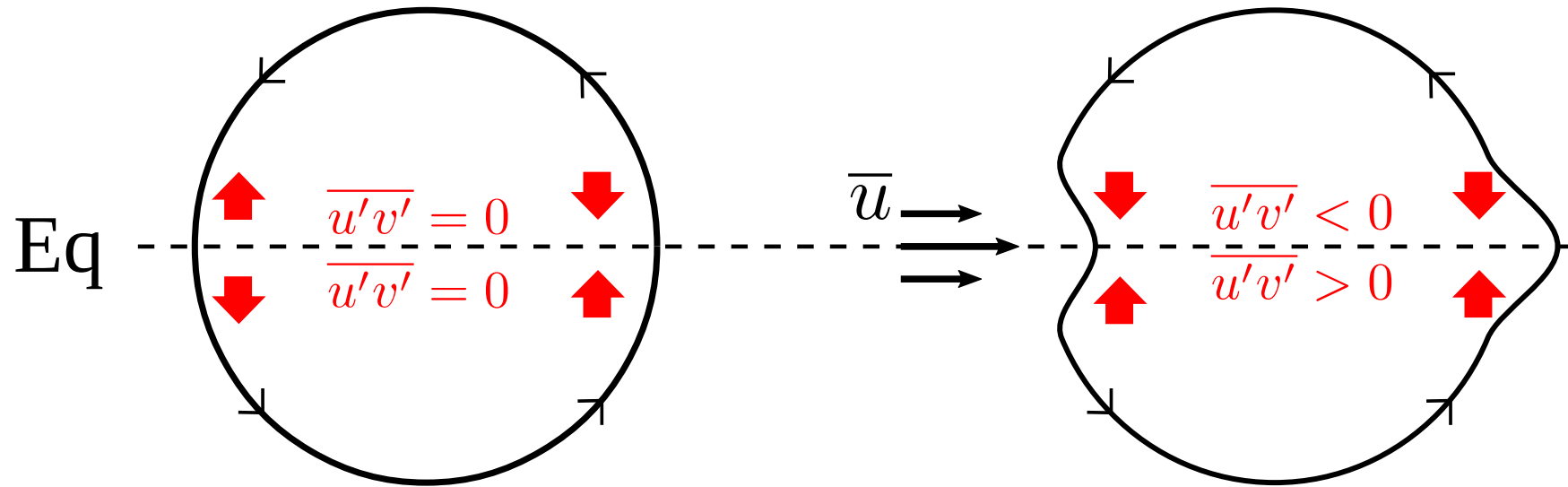
Reconstructed forcing of the EDJs



All vertical modes

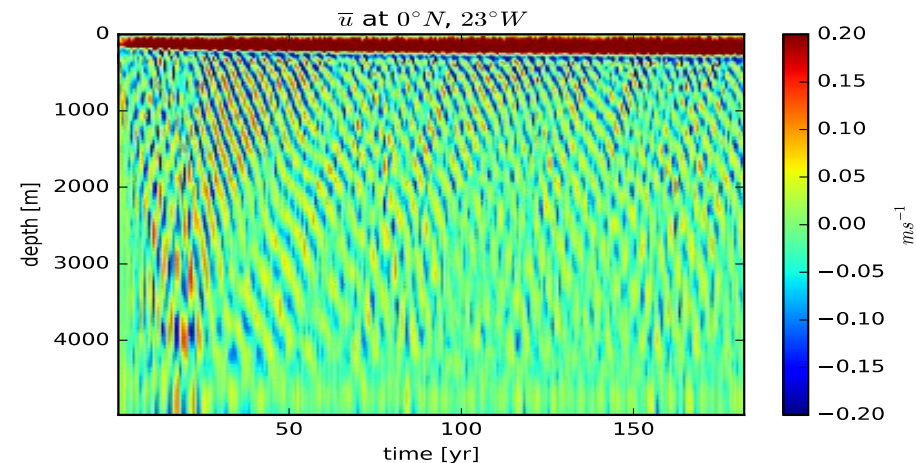
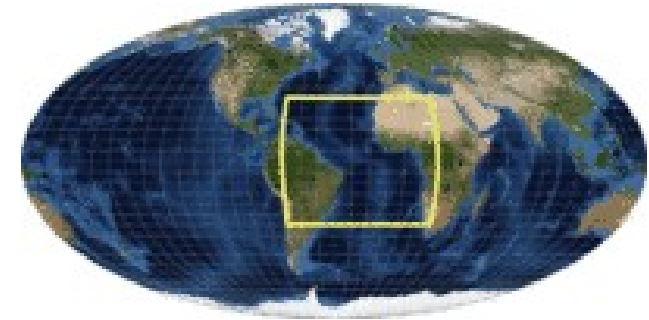
Vertical modes 13 to 23

Reynolds-averaged momentum equations



$$\bar{u}_t - f\bar{v} = -\rho_0^{-1}\bar{p}_x - \frac{\partial \bar{u}}{\partial x_j} \bar{u}_j - \overline{u'u'_x} - \overline{u'v'_y} - \overline{u'w'_z}$$

- TRATL01
 - NEMO gcm driven by CORE2 forcing
 - 1/10° tropical Atlantic nested in 0.25° global ocean
 - seasonal cycle but no EDJs
- BOX model
 - 0.25° MITgcm driven by zonally uniform constant windstress
 - high vertical resolution (L200), flat bottom
 - EDJs but no seasonal cycle
- Mooring data
 - 3 moorings at 23°W: 0°45'N, 0°N 0°45'S
 - measurements down to 3500 m



- Starting point

$$\bar{u}_t - f\bar{v} = -\rho_0^{-1}\bar{p}_x - \frac{\partial \bar{u} \bar{u}_j}{\partial x_j} - \overline{u'u'_x} - \overline{u'v'_y} - \overline{u'w'_z}$$

- Reynolds decomposition

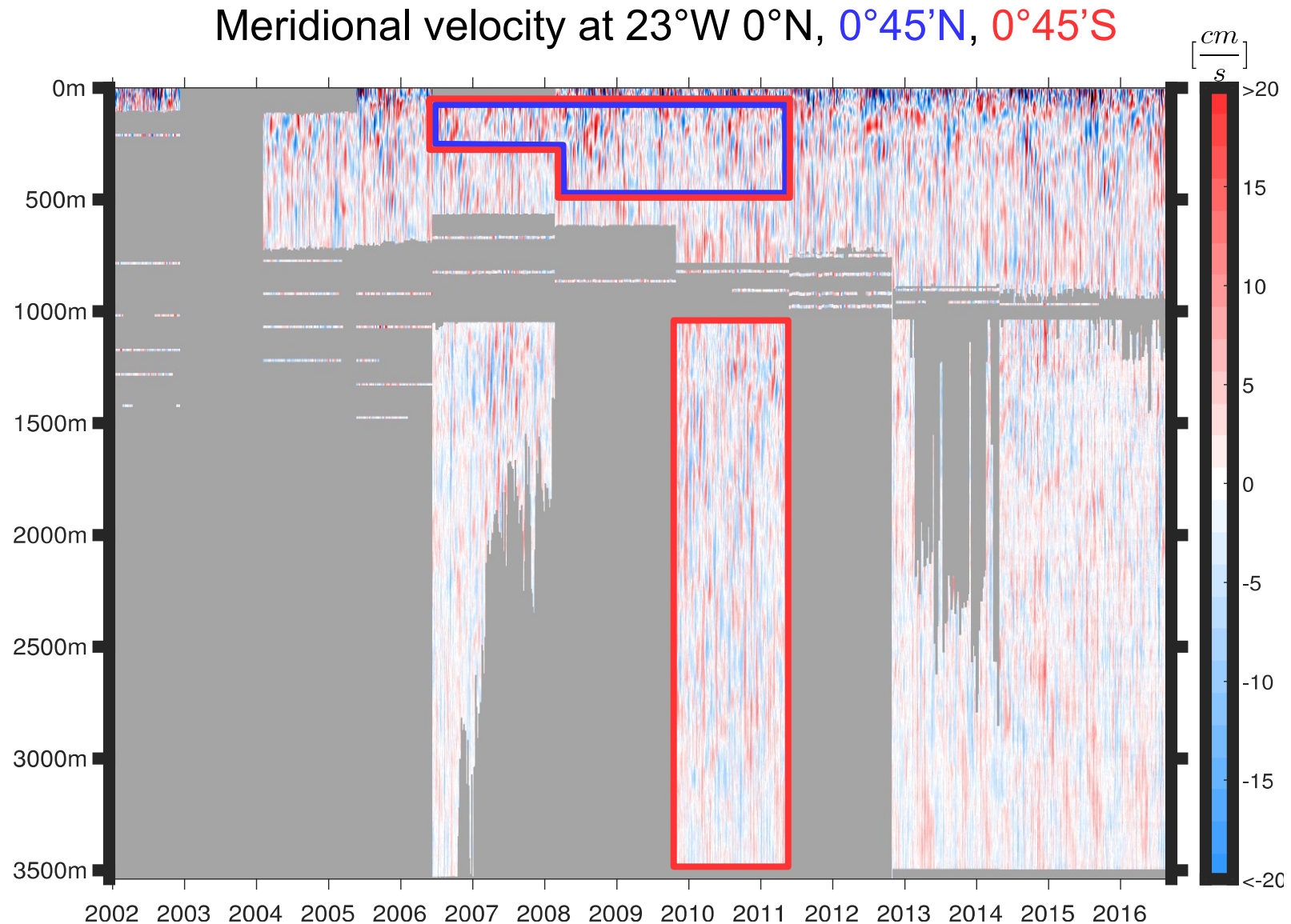
$$u = \bar{u} + u' + u_0 \quad \bar{u} : 70 \text{ day low-pass filtered}$$

- Regress the meridional divergence of intra-seasonal momentum flux convergence onto \bar{u}

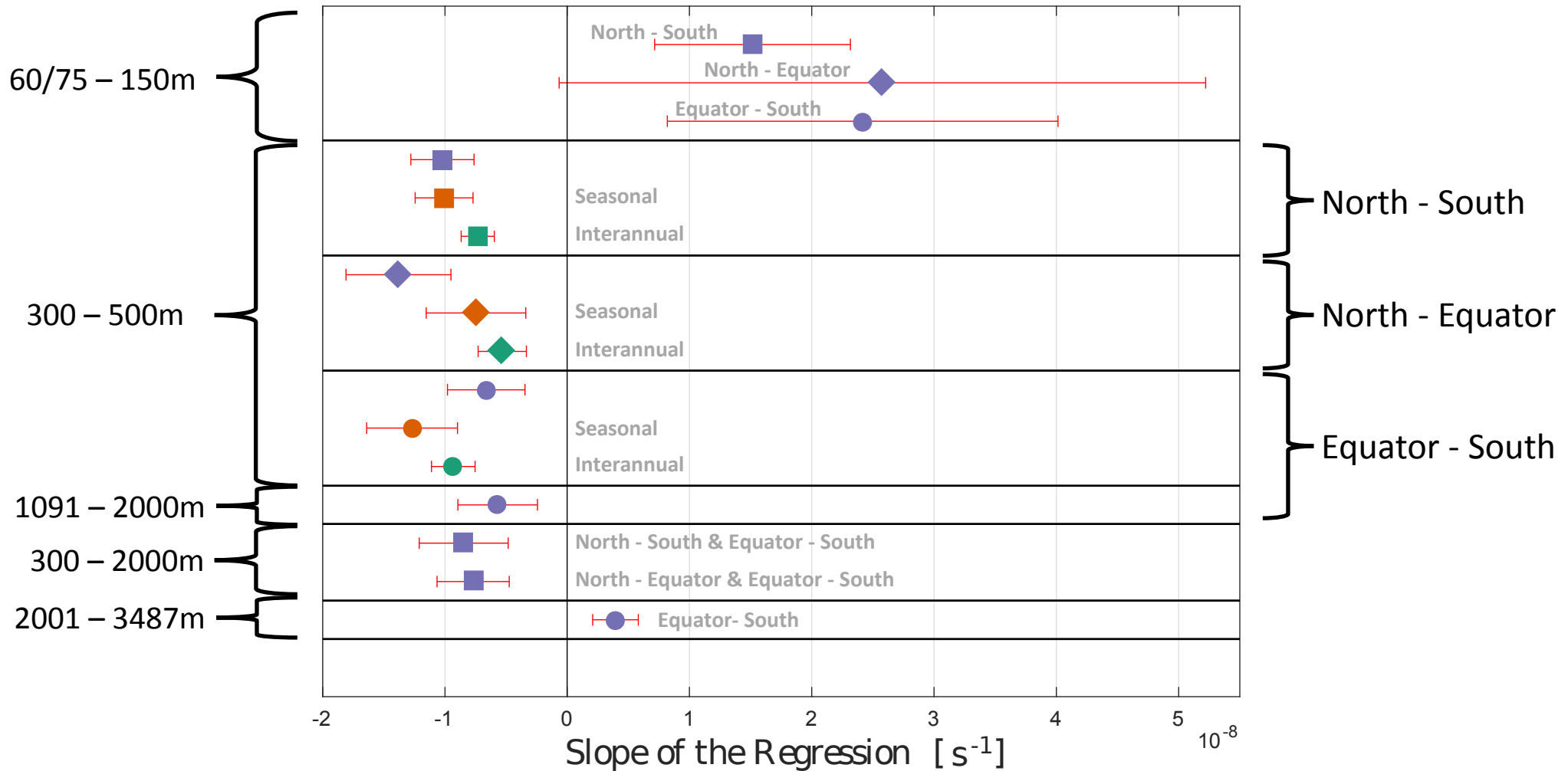
$$(u'v')_y = s\bar{u} + c$$

If $s < 0$, the intra-seasonal momentum flux convergence maintains \bar{u}

Observations at 23°W

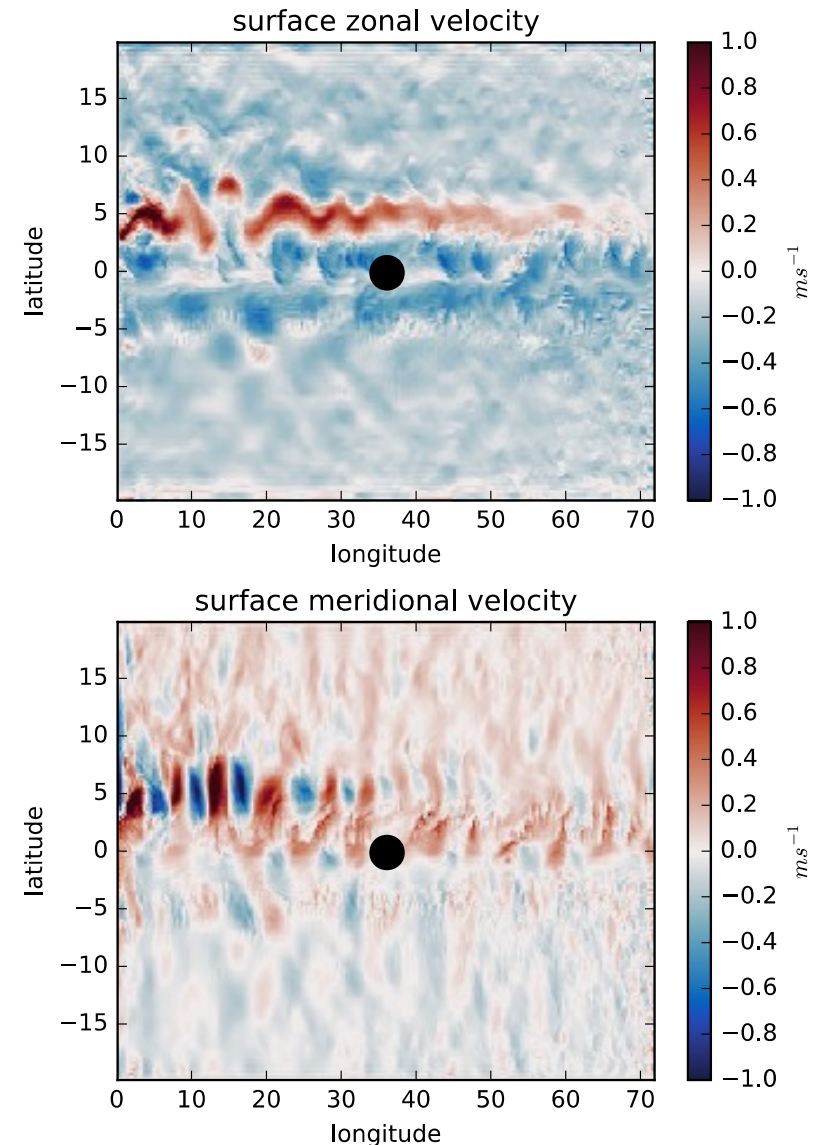
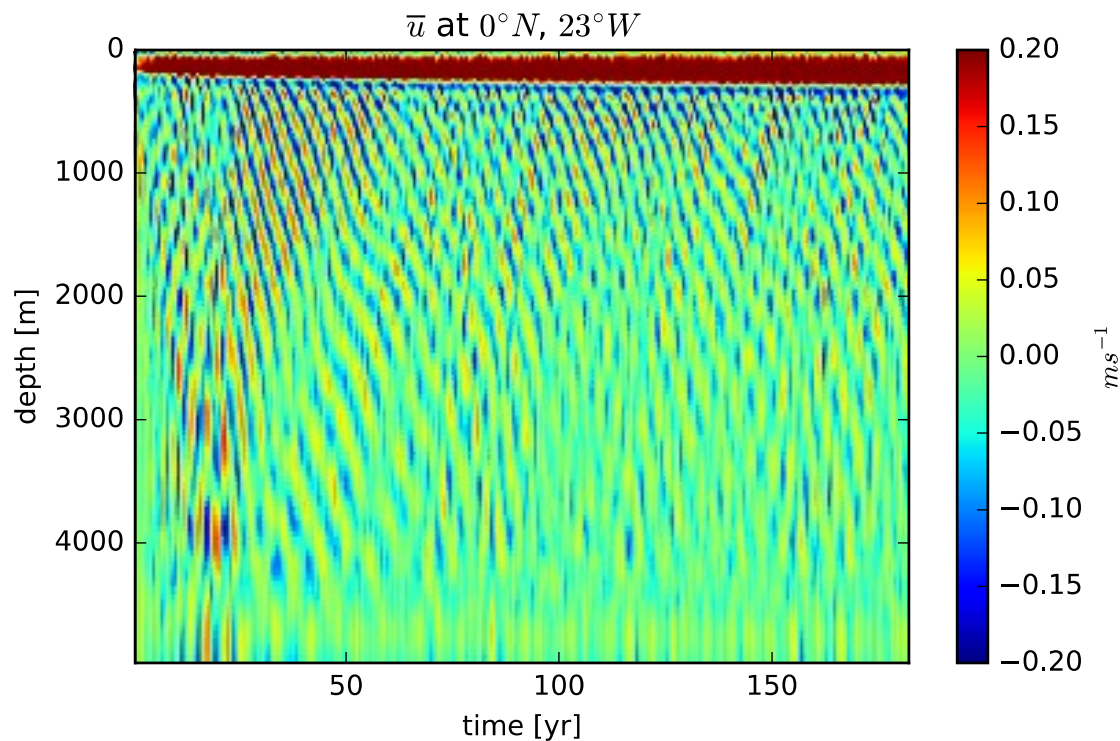


Seasonal cycle of intra-seasonal meridional kinetic energy

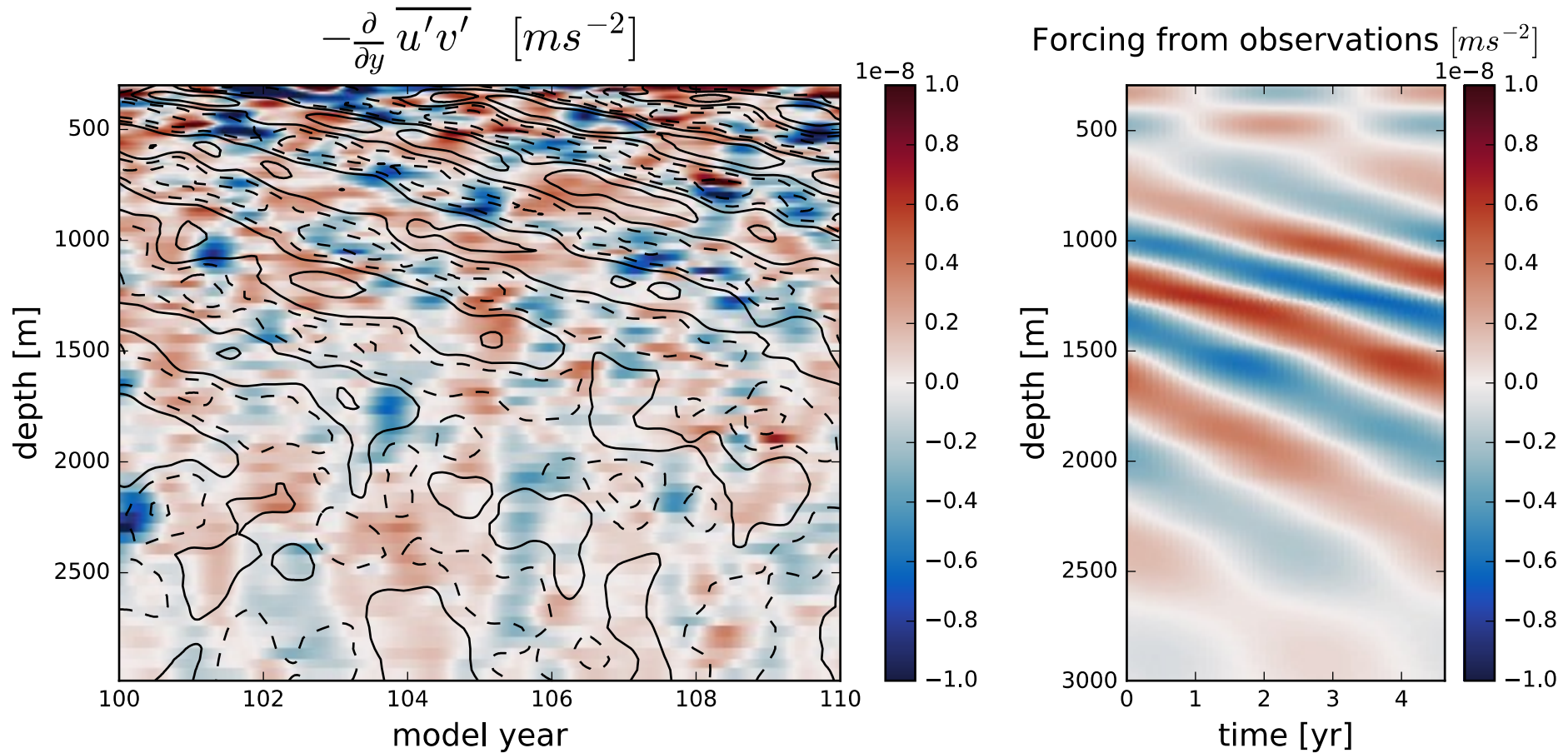


Setup of the BOX model

- $0.25^\circ \times 0.25^\circ$, 200 vertical levels
- Linear equation of state, no salt
- Driven by steady wind stress

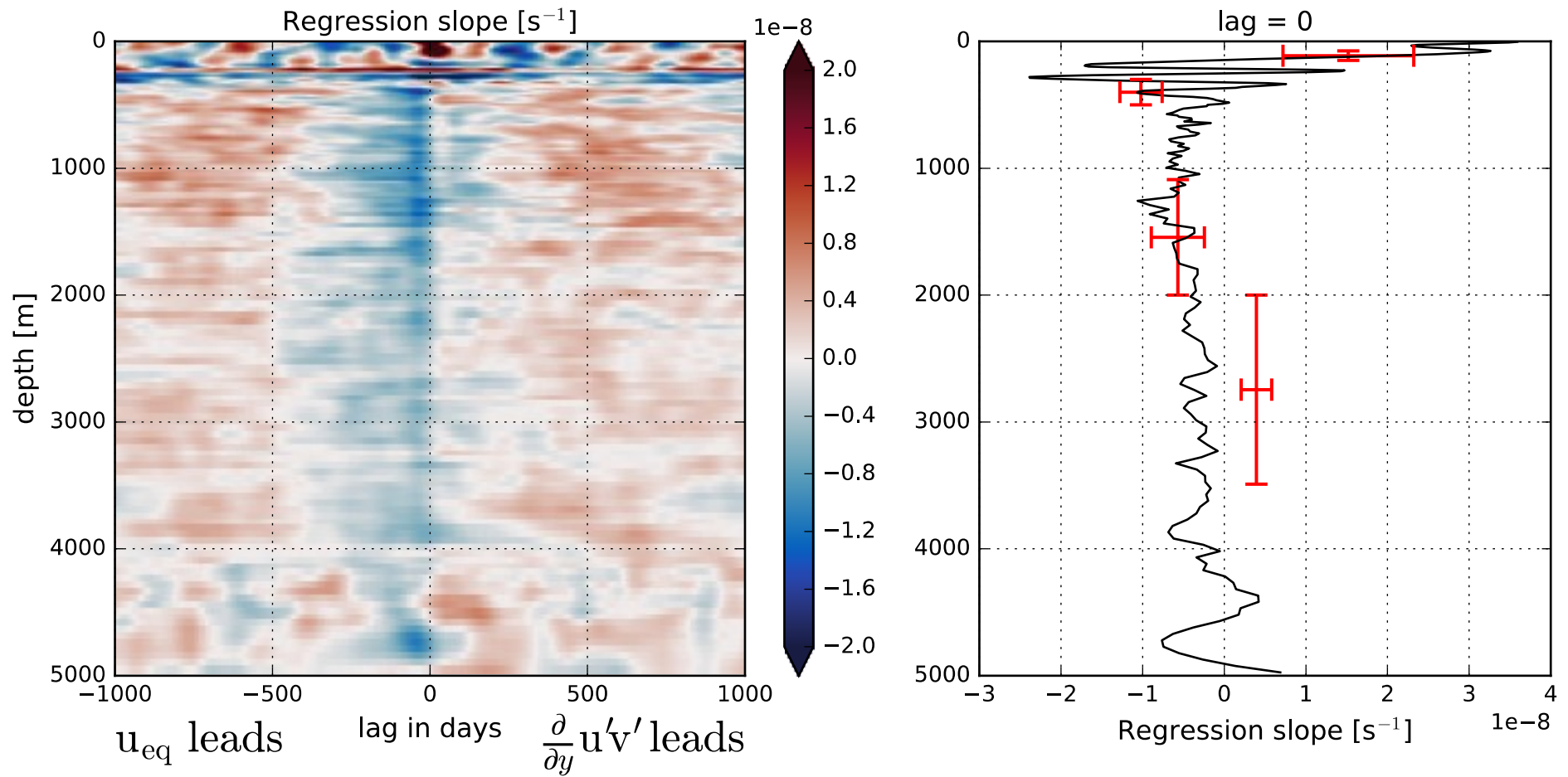


Convergence of the intra-seasonal momentum flux in the BOX model



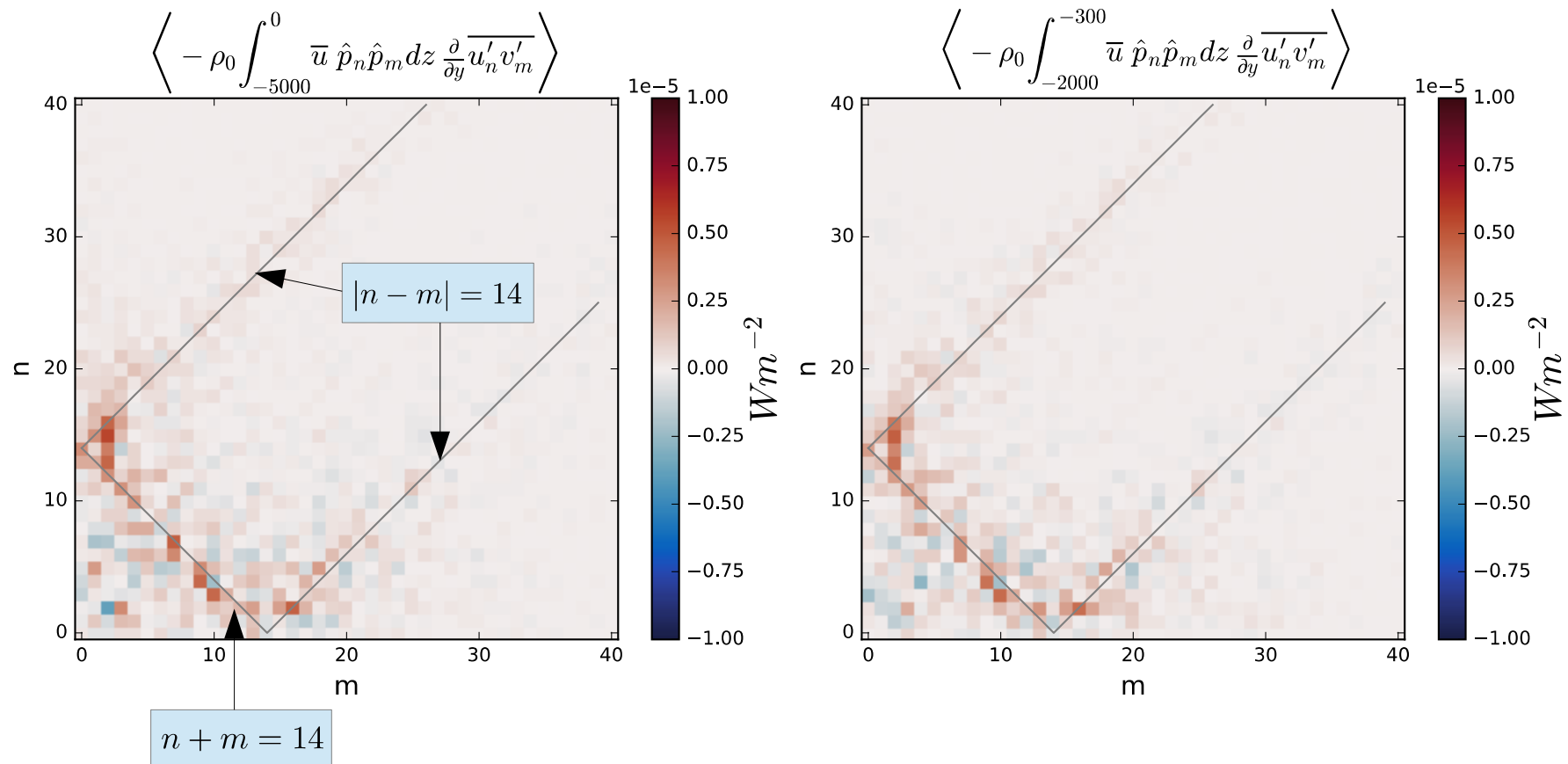
Update of Claus et al. (2016)

Intra-seasonal Reynolds stress



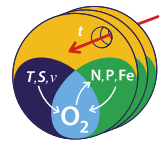
Modal decomposition of power input

$$-\int_{-H}^0 dz \rho_0 \bar{u} (\overline{u'v'})_y = -\rho_0 \sum_n \sum_m \overline{(u'_n v'_m)}_y \int_{-H}^0 dz \bar{u} \hat{p}_n \hat{p}_m$$

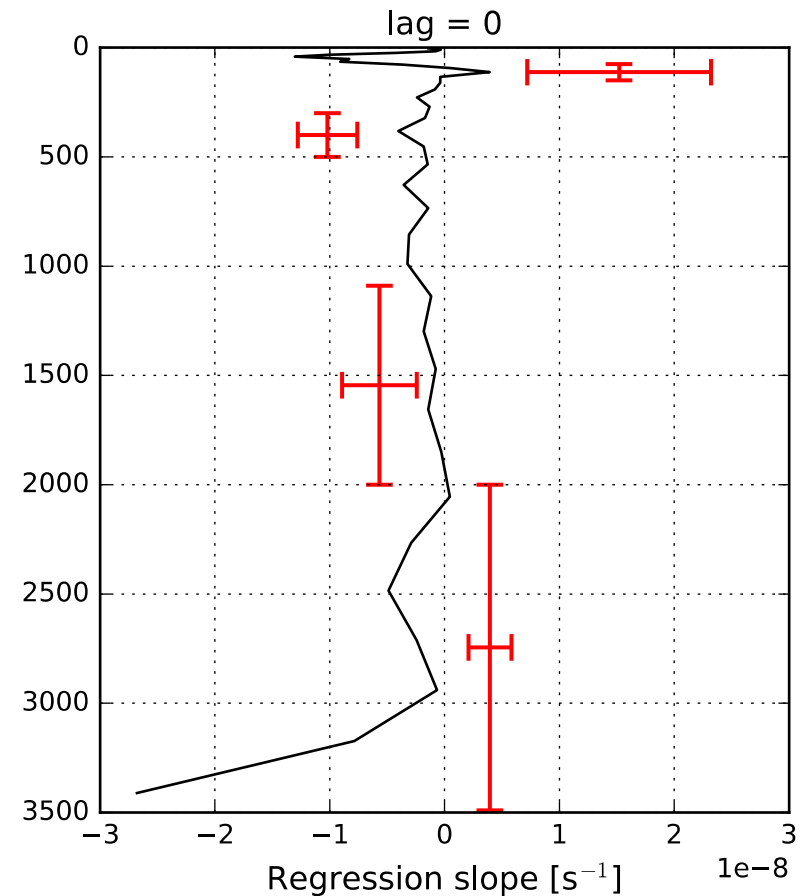
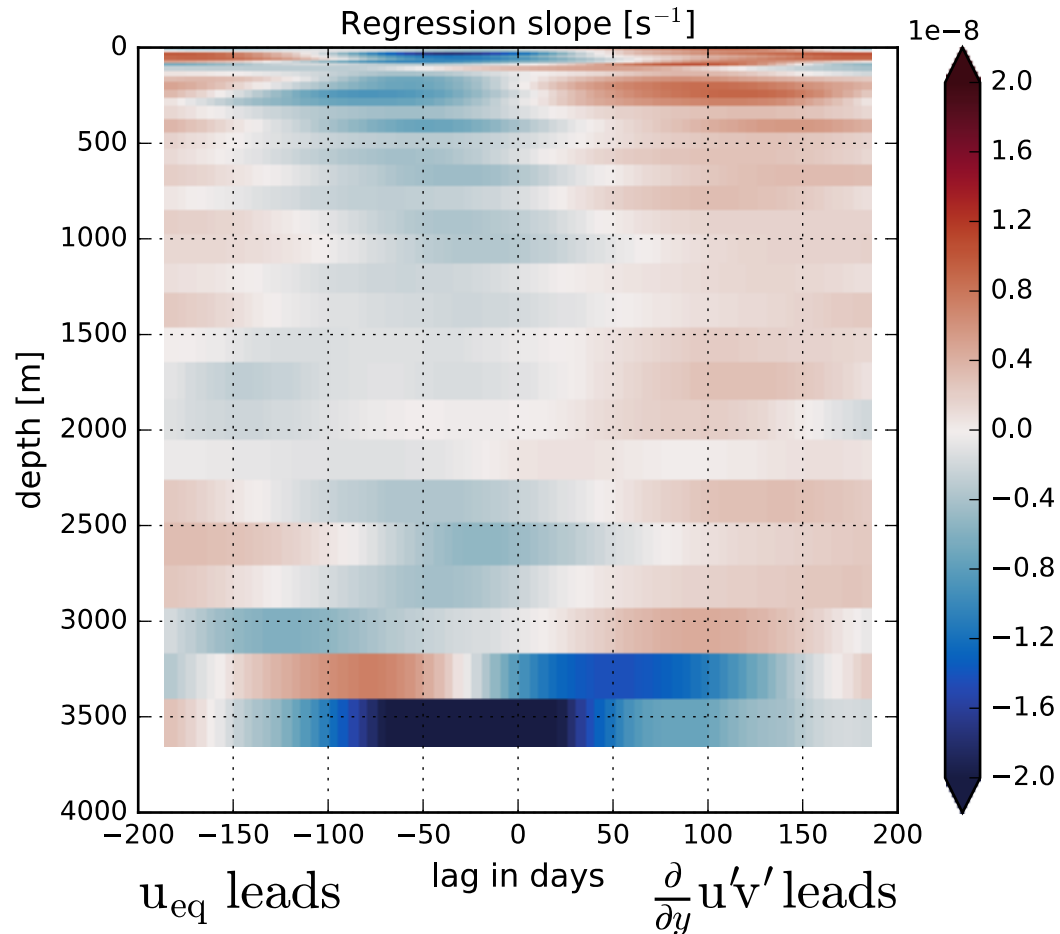


Regression of intra-seasonal momentum flux divergence in TRATL01

GEOMAR



SFB 754



- Equatorial basin mode resonance is an important feature of the equatorial ocean variability
- EDJs and the seasonal cycle are maintained against dissipation over a considerable depth range
- The convergence of the meridional flux of intra-seasonal zonal momentum maintains the lower frequency variability